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## PROCESS FOR MAKING CHEESE

## CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority of U.S. Provisional Patent Application  
5 No. 60/271,807, the entire disclosure of which is incorporated herein by reference.

## BACKGROUND

The consumption of cheese continues to grow due to the varieties and forms  
available to the consumer and due to the popularity of Italian and Mexican foods such  
10 as pizza and tacos. Such foods, whether prepared at home or eaten out, often utilize  
cheese in a sliced, shredded or diced form. As popular foods develop and change, cheese  
performance expectations have broadened. Traditional cheeses, such as mozzarella and  
cheddar, are being modified to meet expectations and remain competitive. Although  
technologies have been developed to improve performance and reduce cost, a need still  
15 exists to streamline processing, provide new functionality, and narrow the quality gap  
between traditional cheeses and alternatives, which may include pizza cheese and taco  
cheese.

Pizza cheese and taco cheese are non-standard cheeses, which may contain safe  
and suitable food ingredients not specified in the standard of identity for mozzarella  
and cheddar cheeses. They often contain higher moisture, some form of starch, low cost  
20 dairy solids, emulsifying salts, gums and flavorings.

The quality level of pizza cheese differs from traditional mozzarella in flavor,  
texture, and melt. In addition, the handling requirements for frozen pizza cheese are  
significantly different. One of the leading manufacturers of pizza cheese requires the  
product to be frozen to accommodate higher moisture contents and prevent rapid aging.  
25 Quality attributes and economic advantages have been known to disappear with  
improper thawing of frozen cheese.

Cheddar cheese still appears to be the leading choice for taco applications.  
Lower cost alternatives, such as processed cheese and imitation cheese, have negative  
30 connotations and lower perceived quality. The concept of taco cheese, a non-standard  
fresh cheese resembling cheddar, is generally analogous to the application of pizza  
cheese on pizzas. Quality and functionality can be refined for application on tacos.

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## 1 SUMMARY OF THE INVENTION

It is the objective of the present invention to provide a method for producing a fresh, not frozen, cheese in a convenient form that has the economic advantage of optimized curd production separated from the development of functional properties by utilizing a streamlined manufacturing process. It is a further objective of this invention to provide a method for producing a fresh cheese that has early melt and longer shelf life characteristics. It is still a further objective of this invention to develop a method for making a fresh cheese with enhanced flavor and melt properties for application on pizza and tacos. Although the invention is particularly suitable for mozzarella-like cheese, it can be extended to cheddar-like and other cheeses.

## DETAILED DESCRIPTION

In accordance with the methods of the invention, milk is standardized and pasteurized, as is generally known in the art. In one embodiment, the milk is fortified with ultrafiltered milk concentrate, water, nonfat milk solids, condensed skim milk, cream, or the like to increase the casein/fat ratio of the standardized milk product, i.e., to add protein the standardized milk product. Preferably the standardized milk contains protein in an amount ranging from about 3 wt.% to about 6 wt.%, more preferably from about 3.5 wt.% to about 4.5 wt.%, and fat in an amount ranging from about 1 wt.% to about 5 wt.%, more preferably from about 3 wt.% to about 4 wt.%.

By increasing the casein/fat ratio early in the process, less fat is wasted through removal with the whey. The fat content of the cheese product is then increased later in the process through the use of an extender, as described in more detail below.

The standardized milk is pasteurized by heating to a suitable temperature, e.g., about 190°F. The pasteurized milk is then cooled to a temperature preferably ranging from about 92°F to about 100°F, more preferably about 96°F.

The cooled milk is added to a conventional cheese vat, stirred and inoculated with acid-producing bacteria. Lactic acid-, hetero-acid, and flavor producing bacteria for use in cheese making are well known in the art and the choice of a particular bacterium or combination of bacteria will depend on the type of cheese to be produced. Representative bacteria suitable for practice of the invention include, without limitation, *S. cremoris*, *S. lactis*, *S. citrovorus*, *S. paracitrovorus*, *S. thermophilus*, *S. durans*, *S. diacetylactis*, *S. faecalis*, *L. acidophilus*, *L. bulgaricus*, *L. brevis*, *L. casei*, *L. delbrueckii*, *L. fermenti*, *L. helveticus*, *L. lactis*, *L. plantarum*, *L. thermophilus*, *leuconsostoc citrovorum*, *leuconsostoc mesenteroides*, *Bacteriumlinesn*, *Micrococcus*

1 caseolyticus, *Pediococcus cerevisiae*, *Pseudomonas fraga* and propionibacterium species,  
such as *Propionibacterium shermanii*. Preferably a cultured starter medium containing  
2 Streptococcus thermophilus is added to facilitate high moisture with minimal protein  
breakdown. The standardized cheese milk is preferably preacidified to a pH of about  
5 6.3. Food grade acids such, as lactic acid, acetic acid, phosphoric acid, citric acid and  
combinations thereof, can be used pre and post-pasteurization to help facilitate  
lowering the pH. It has been found that a secondary starter system, such as described  
in US Patent 5,895,671, the disclosure of which is incorporated herein by reference,  
provides a desirable texturing effect for incorporation of an extender. The targeted  
10 composition of the optimized curd is preferably about 30 to about 45%, more preferably  
about 42%, FDB (fat on dry basis) and preferably about 45 to about 55%, more  
preferably about 50%, moisture.

The mixture is stirred under suitable conditions, e.g., at about 96°F for about  
one hour. A clotting enzyme is mixed into the ripened milk to cause the milk to  
15 coagulate. Suitable clotting enzymes include rennet, rennin, diluted rennin extract,  
vegetable-derived enzyme clotting agent and the like. Other enzymes such as pepsin  
and papain may be used alone or in combination with the rennet or rennin. After  
addition of the clotting enzyme, the mixture is allowed to set without stirring for about  
20 to 40 minutes, typically about 30 minutes, to form a firm, set coagulum.

20 The solid mass is then cut and stirred to release the whey. The curd in whey  
mixture is heated to facilitate cooking of the curd, thereby expelling the whey. The  
curd is then separated from the whey by draining, and then the curd is cut into pieces  
for further processing. See generally *Cheesemaking Practice* 2<sup>nd</sup> edition R. Scott  
Elsevier Applied Science Publishers, the disclosure of which is incorporated herein by  
25 reference.

Cheese cost and functionality may be controlled by inclusion of a cheese  
extender. The cheese extender contains a source of fat, as well as one or more other  
ingredients such as water, low cost solids, cheese solids, emulsifying salts, and  
flavorings. The extender ingredients may be combined in a separate processing step  
30 or added directly to the molten cheese during the pasta filata mixing. It is preferred  
to make the extender in a separate processing step for better control and more efficient  
incorporation.

The source of fat may be added in any suitable form, such as butter, plastic  
cream, plastic fat, anhydrous milk fat, cream, whey cream, vegetable fat, or animal fat,  
35 to achieve the desired fat level in the finished cheese, which is preferably from about

1 35 to about 50% FDB, more preferably from about 35 to about 45% FDB. It is  
advantageous to keep the fat from becoming completely dispersed or homogenized into  
the extender and cheese curd, as this will result in poor melt performance. It is  
5 preferred to gently incorporate the fat as a marbled phase or loosely bound  
ingredient with minimum shear.

The low cost solids are conveniently supplied in the form of starch, maltodextrin,  
and/or nonfat milk solids to promote moisture retention and modify texture for  
application targeted melt and chew. The emulsifying salts may vary, but citrates and  
phosphates are preferred to condition the protein for moisture and fat retention. Such  
10 a starch-based extender may be produced by cooking native rice or tapioca to a paste  
under high temperature and shear followed by gentle incorporation of fat and other  
ingredients under low shear, or by cooking modified or unmodified food starch to a  
paste and gently incorporating fat and other ingredients.

The extender may be added to fresh cheese curd after whey separation, to melted  
15 cheese during a traditional pasta filata processing step, or to aged cheese in a separate  
processing step. If the extender is added to curd directly after whey separation,  
preferably the curd is first passed through a grinder (such as a Wolfking grinder,  
commercially available from Wolfking A/S, Slagelse, Denmark) to create more surface  
area for contact with the extender. The temperature of incorporation is preferably  
20 about 160°F under medium shear, followed by cooling to about 135-145°F under low  
shear or kneading action. During this cooling step any liquid phase that may have  
separated during the incorporation will be reincorporated and the melted mass will  
develop the traditional structure of melted cheese.

If the extender is incorporated into melted cheese curd, the temperature of  
25 incorporation is preferably in the normal pasta filata range of 135-145°F and  
subsequent cooling is not necessary. This may be done in a conventional pasta filata  
mixer/molder. If the extender is prepared as a separate step and incorporated into  
melted cheese, it is very important to control the viscosity of the extender to be  
compatible with, i.e. about the same as, the viscosity of the melted cheese. If the  
30 viscosity of the extender is either too high or too low, it will not incorporate properly,  
rendering the mixture unfit for further processing. Additionally, the curd or melted  
cheese cannot be so high in viscosity or tough that it will not soften and mix properly  
with the extender. It has been found that a curd made in accordance with US Patent  
5,895,671, having a moisture of about 48-50%, fat-dry basis (FDB) of about 38-42%, and  
35 a pH of about 5.1-5.4, provides a very pliable texture for incorporating the extender.

1 In one embodiment, a 40 lb batch of extender is prepared by mixing 22.5 lb cold  
water, 4.8 lb cold whey cream, and 0.7 lb sodium tripolyphosphate in a processor  
equipped for direct steam heating and high shear mixing, such as a Readco Continuous  
Processor, commercially available from Readco Manufacturing, Inc. (York,  
5 Pennsylvania). About 2.7 lb modified food starch (Frigex W -- National Starch) is slowly  
added with high shear to prevent lumping. After the starch is hydrated, the mixture  
is heated to at least about 170°F with stirring until the mixture thickens and the starch  
is cooked out. About 2.1 lb starch-maltodextrin compound (Gel 700 -- USP Technologies)  
is melted and added to the hot mixture under high shear mixing. About 4.8 lb plastic  
10 cream is then added, and the final mixture is heated to about 195°F for about 10  
minutes. The extender can then be added to the cheese.

In another embodiment, some of the extender solids are made up of cheese solids  
and flavorings. For example, a 40 lb extender can contain 6.2 lb water, 1.8 lb whey  
cream, 1.8 lb plastic cream, 0.3 lb sodium tripolyphosphate, 0.2 lb salt, 0.05 lb annato  
15 color, 0.9 lb modified food starch, 28.2 lb cheddar cheese, and 0.55 lb Cheddar flavor.

In a preferred embodiment, a closed system processor is used to incorporate the  
extender into fresh curd, heat the curd and work the curd into a homogeneous mass.  
The processor heats the curd using steam rather than hot water. It also reincorporates  
any separated liquid phase so that no components are lost. In a traditional processor,  
20 which also can be used in accordance with the invention, the curd is kneaded and  
stretched in hot water, but not sheared due to the significant amount of fat that would  
be lost in the cooker water. However, it is preferred to shear the curd to incorporate  
the extender uniformly in the cheese body. A preferred closed system processor is the  
Readco Continuous Processor, commercially available from Readco Manufacturing, Inc.  
25 (York, Pennsylvania). The processor includes a high shear paddle extruder that mixes  
the curd and other ingredients quickly and uniformly. The paddle angles can be  
adjusted so that the product can be sheared or kneaded.

Preferably mixing is performed in two stages. In the first stage, the ingredients  
are mixed under high shear, for example, using a low shear paddle configuration at 300  
30 rpm with a 40 HP load, and heated, preferably to about 135 to about 165°F. In the  
second stage, the ground ingredients are kneaded to align the proteins in a  
unidirectional orientation, as will be discussed further below.

In one embodiment, 185 lb fresh curd, containing 54 % moisture and 16.5% fat,  
is mixed with 15 lb extender in a jacketed processor equipped for high and low shear  
35 mixing. The mixture is heated to 160 to 170°F, preferably about 165°F, and mixed

1 under high shear until the mass is homogeneous. The mass is then cooled to about 135  
to 145°F, preferably about 140°F, under low shear, kneading action. In another  
embodiment, 185 lb melted cheese curd, containing about 49% moisture and 24% fat,  
is mixed with 15 lb extender in a jacketed processor equipped for medium shear mixing.  
5 The mixture is heated to maintain a temperature of about 135 to 145°F, preferably  
about 140°F, until the mass is homogeneous.

After the molten cheese, with or without extender, is removed from the  
processor, it is preferably extruded and cut prior to brining. Improved yield and  
quality can be achieved after the cheese has been formed and cut in the molten state  
10 with proper cooling. Rapid cooling results in a quick structure formation and efficient  
retention of liquid phase components. It is preferred that the brine temperature be as  
low as possible, preferably at least about 20°F, more preferably from about 20 to about  
25°F, in order to facilitate cooling and retard the uptake of salt. Because the cheese in  
the brine absorbs salt, it is important to control the salt content of the cheese prior to  
15 brining to allow enough time for temperature reduction at the center of the chunk  
during the brining. Controlling the salt prior to brining can be accomplished by  
limiting or eliminating the addition of salt, cooker water or whey cream to the cheese  
curd, melted cheese and extender.

Preferably the cheese-extender mixture is extruded as a continuous rope, having  
20 a diameter ranging from about 1 to about 3 inches and a length ranging from 3 feet to  
about 7 feet, through a trough of cold water before being cut and brined. The partially  
cooled rope, which is preferably at a temperature ranging from about 110°F to about  
150°F, is then cut into smaller sections, preferably having a length ranging from about  
2 inches to about 6 inches. The smaller chunks are then conveyed into a brine system,  
25 preferably at a temperature ranging from about 20°F to about 30°F, for further cooling.  
The chunks are allowed to soak in the brine until sufficiently cooled. Preferably the  
chunks are in the brine for a time period ranging from about 15 minutes to about 90  
minutes, more preferably from about 30 minutes to about 60 minutes.

Once the chunks are cooled, preferably to a core temperature of about 36 to  
30 about 44°F, more preferably about 40°F, they are removed from the brine, rinsed to  
remove the salt, air blown to remove excess water, and conveyed directly to a standard  
cheese shredder or dicer. If the brine temperature is about 20-25°F, it will take about  
45 to about 60 minutes to reach a core temperature of about 45°F, and the salt level  
will be about 1.6 to about 2%. No intermediate packaging or cold storage is required  
35 as in a traditional pasta filata process. Additionally, no extra handling or sizing is

1 required to prepare the cheese for slicing, shredding or dicing. An alternate method of  
size reduction involves the use of a water cannon. Cooled chunks are removed from the  
brine and transported in a stream of water under high pressure through a fixed set of  
knife blades. The resulting cheese pieces are separated from the water stream and  
5 dried prior to packaging. The water cannon has the advantage of reducing fragmented  
pieces and eliminating heat build up during size reduction.

The cut form may advantageously be designed to go directly to a cheese shredder  
or dicer without further packaging or sizing. In some embodiments, the cut form may  
be the final form of the product for customers, e.g. slice, dice or shred. Not only is the  
10 cut form convenient and efficient in shape, but its texture is improved by the extrusion  
prior to cutting. In a traditional pasta filata process, molten cheese is pumped into a  
forming mold prior to brining. This pumping action creates folding of cheese layers,  
which results in a random orientation of protein structure. The method of the present  
invention, through the extrusion step, creates a laminar flow, which results in  
15 unidirectional orientation of protein structure. This unidirectional orientation of  
protein structure allows for efficient alignment of the cheese to the blade of a typical  
cheese slicer, shredder or dicer. The efficient alignment of cheese structure with the  
cutting blades yields long smooth pieces with fewer fragmented pieces when compared  
to the traditional random structured-cheese.

20 In a preferred embodiment, a cheese-extender mass at 140°F is fed through an  
extruder where the temperature drops to about 130 to 135°F and the mass is shaped  
into a rope about 1.5 to 2.5 in, preferably 2.0 in, in diameter. The rope is cut  
continuously into sections having a length of about 2 to 8 in, preferably about 4 in. The  
ratio of the diameter of the extruded rope to its cut length preferably ranges from about  
25 1:1 to 1:4, more preferably about 1:2. The resulting chunks are conveyed by cold water  
to a saturated brine system, 90% minimum salinity, set at about 20-25°F. The chunks  
are left floating in the brine until the core temperature has reached about 45°F or  
below, preferably below 40°F, and the final salt content is not more than 2.0%,  
preferably not more than 1.8%. The cooling should take place as rapidly as possible to  
30 develop structure and targeted melt properties, preferably over a time period ranging  
from about 15 minutes to about 120 minutes, more preferably from about 30 minutes  
to about 60 minutes.

In one embodiment, the cooled chunks are then removed from the brine system,  
rinsed with cold water, and blown dry. The dry chunks may then be placed directly  
35 into a conventional slicer, shredder, or dicer to obtain the final form of the cheese.

1 Packaging the slices, shreds, or diced particles is done in the usual manner. In another  
embodiment, the cooled chunks are removed from the brine system, drained, and placed  
in a continuous stream of cold water, which conveys the chunks under high pressure  
through a set of fixed blades to achieve the final form of the cheese. The resulting  
5 pieces are separated from the water stream, drained, blown dry and packaged in the  
usual manner. In another embodiment, the cooled chunks are separated from the brine  
and conveyed by a high-pressure stream of cold water through a static cutter to achieve  
the final cut form of the cheese. The high pressure stream flows through a pipe, which  
is preferably about 0.25 to 0.5 in greater than the width of the cheese chunk to provide  
10 a tight tolerance, creating sufficient flow pressure to go through the static cutter. After  
cutting the cheese pieces are separated from the water and dried prior to packaging.

Cheese manufactured by the present invention preferably has a finished  
composition of about 45 to about 65%, more preferably from about 50 to 56%, moisture;  
from about 30 to about 50%, more preferably from about 35 to about 45%, FDB (fat-dry  
15 basis); and from about 1 to about 3 %, more preferably from about 1.6 to about 2.0%,  
salt; with a pH ranging from about 4.8 to about 6.0, more preferably from about 5.1 to  
about 5.4. Without having to be frozen, this cheese has the distinct advantages of early  
melt, about 10 days, and longer shelf life, 60 – 90 days, when compared to traditional  
Mozzarella, requiring about 14 days to melt and having a shelf life of about 45 days.  
20 When melted on a pizza or taco, the texture of this cheese remains soft and pliable for  
a longer period of time and has a full-bodied flavor and aroma.

## Examples

### 25 Example 1 - Preparation of Cheese Curd and Melted Cheese

Milk that has been standardized with UF milk concentrate and cream to a 4.0%  
protein and 3.5% fat level is pasteurized and cooled to 96°F. About 47,189 lb of the  
standardized milk is added to a conventional cheese vat while under gentle agitation.  
Next, 12 cans of frozen starter culture containing *Streptococcus thermophilus* bacteria,  
30 800 lb of secondary starter medium prepared in accordance with US Patent 5,895,671,  
is added, and the mixture is allowed to agitate slowly for about 60 minutes. Sufficient  
coagulant, about 28 oz, is added to convert the cultured milk to a solid curd in about 27  
minutes. After the curd mass forms, it is cut, heated and cooked to 108°F, and stirred  
for 5 min following normal cheesemaking practices. The cut curd in whey is  
35 discharged onto a draining belt where the whey is removed and the curd body develops.



1 When the pH of the drained curd is about 5.2, the curd is cooled under a cold water  
spray and cut into curd pieces of about 3/8 by 3/8 by 3 inches for further processing.  
The yield of curd, 50.5% moisture and 42.5% FDB (fat-dry basis), was 7114.8 lb,  
14.82%.

5 Melted cheese was obtained by placing about 400 lb of the curd pieces into a  
standard pasta filata cooker and heating directly with hot water to about 130 to 140°F.  
No salt was added to the cheese curd or the cooker water.

#### Example 2 - Preparation of Pizza Cheese Extender

10 A 40 lb batch of extender is prepared by placing 22.5 lb cold water, 4.8 lb cold  
40% fat whey cream, and 0.7 lb sodium tripolyphosphate in a steam injection processor  
equipped with high and low shear mixing. About 2.1 lb of modified food starch (Frigex  
W – National Starch) is added slowly to the cold liquid mixture under high shear  
mixing. After the starch has hydrated, the mixture is heated by direct steam to about  
15 170°F and held under low shear mixing until the consistency is thick and smooth.  
Then 2.1 lb of a starch-maltodextrin compound (Gel 700 – USP Technology) is melted  
at about 180°F and added to the extender mixture under low shear mixing. Finally,  
about 4.9 lb of plastic cream is added while stirring and the mixture is heated to 195°F  
for about 10 minutes.

#### Example 3 - Preparation of Taco Cheese Extender

20 A 40 lb batch of extender is prepared by placing 3.5 lb cold water, 1.8 lb 40% fat  
whey cream, and 0.3 lb sodium tripolyphosphate in a steam injection processor  
equipped with high and low shear mixing. About 0.9 lb modified food starch (Frigex W  
– National Starch) is added slowly to the cold liquid mixture under high shear mixing.  
After the starch has hydrated, the mixture is heated by direct steam to about 170°F  
and held under low shear mixing until the consistency is thick and smooth. Then 28.2  
lb cut Cheddar cheese, 1.8 lb plastic cream, 0.63 lb Cheddar flavor (H&R Flavors), 0.2  
lb salt, and 0.05 lb annatto color are added to the mixture. Steam used during heating  
30 adds 2.62 lb water.

#### Example 4 - Extender with Fresh Cheese Curd – Pizza Cheese

35 Cheese curd prepared as described in Example 1, about 185 lb, and extender  
prepared as described in Example 2, about 15 lb, are placed in a jacketed continuous  
processor with agitation designed for high initial shear and high initial temperature

1 progressing to low exit shear and low exit temperature. Such a processor is available  
from Readco. The mixture is processed at an initial temperature of 160°F under high  
shear followed by a cooling to 140°F under low shear. Product exiting the processor is  
homogeneous and the texture is fibrous, much like Mozzarella cheese.

#### 5 Example 5 - Extender with Melted Cheese Curd – Pizza Cheese

About 185 lb melted cheese, 135 to 145°F, prepared as described in Example 1  
and about 15 lb extender, 170°F, prepared as described in Example 2, are placed in a  
jacketed mixer equipped with medium shear mixing. The mixture is heated to  
10 maintain a temperature of about 140°F while under medium shear mixing. The  
resulting mass is homogeneous and fibrous in texture, much like melted Mozzarella  
cheese.

#### 15 Example 6 - Extender with Melted Cheese – Taco Cheese

About 26.7 lb melted cheese, 135 to 145°F, prepared as described in Example 1,  
and about 13.3 lb extender, 170°F, prepared as described in Example 3, are placed in  
a jacketed mixer equipped with medium shear mixing. The mixture is heated to  
maintain a temperature of about 140°F while under medium shear mixing. The  
resulting mass is smooth and homogeneous with a short texture, much like melted  
20 Cheddar cheese.

#### 25 Example 7 - Extrusion and Brine Cooling

About 200 lb of combined cheese-extender, prepared as described Example 4, at  
a temperature of about 140°F is placed in the hopper of an extruder. The mixture is  
25 extruded as a continuous rope of about 2.0 in diameter through a trough of cold water  
about 6 ft long before being cut into sections about 4 in long. The resulting chunks,  
temperature about 135°F, are conveyed into a brine system, temperature at 23°F, for  
further cooling. After about 45 minutes the core temperature of a typical chunk is  
45°F, and the salt content is about 1.8%. The chunks are then removed from the brine,  
30 rinsed with cold water, and dried under a stream of air. The chunks are now ready for  
final size reduction. The composition of the final cheese is about 53% moisture, 42%  
FDB (fat-dry basis), and 1.8% salt with a pH of about 5.2.

The preceding description has been presented with reference to presently  
35 preferred embodiments of the invention. Workers skilled in the art and technology to

1 which this invention pertains will appreciate that alterations and changes in the  
described methods may be practiced without meaningfully departing from the principal,  
spirit and scope of this invention. Accordingly, the foregoing description should not be  
read as pertaining only to the precise methods described and illustrated in the  
5 accompanying drawings, but rather should be read consistent with and as support to  
the following claims which are to have their fullest and fair scope.

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